AN EVALUATION OF RESULTS OF EXTERNAL FIXATOR IN OPEN FRACTURES OF TIBIAL SHAFT

THESIS

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VINOD KUMAR AGRAWAL

CERTIFICATE

This is to certify that the work entitled " Evaluation of results of external fixation in open fractures of tibial shaft" which is being submitted as a thesis for M.S. (Orthopaedics) Examination, 2000, Bundelkhand University, Jhansi, has been carried out at the Department of Orthopaedics M.L.B. Medical College, Jhansi, by Dr. Vinod Kumar Agrawal under my guidance and supervision. The techniques embodied in this thesis were undertaken by the candidate himself and observation recorded were checked by me from time to time.

He has put in the neccessary stay in the Department as per University regulations.

Dated: 28.2.2000

Dr. P.K. Dabral
M.S.
Professor & Head
Department of Orthopaedics
M.L.B. Medical College
Jhansi
(Guide)

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Vinod Kumar Agrawal

CONTENTS

INTRODUCTION

INTRODUCTION

The dangers associated with open fractures though well accepted now were known even to Sir Perceival Pott nearly two centuries ago, who after sustaining an open fracture of the tibial shaft while horse riding on Old Kent Road refused to be transported till an improvised strecher was arranged.

Sadly, in the present time the incidence of open injuries is much higher. The high velocity vehicular trauma on road particularly with motorcyclists, the excessive risks involved in competitive sports, the growing incidence of terrorists and other revolutionary activities have all contributed the steady rise in incidence.

Open fractures are surgical emergencies in orthopaedics. These fractures are challenge to even the most skilled and experienced surgeon who is faced with such a variety of combination of fractures and associated complications that it may nigh be imposible to decide the best modality of treatment. Improper management may lead to various complications like infection, malunion, non union and even loss of limb. Delay in management may lead to infection and the surgeon may lose the only chance of early fixation.

Management of these fractures is a difficult problem primarily due to soft tissue damage. It provide various complicating variables such as contamination, deviatalization and injuries to blood vessels and nerves. Thus it compromises the ability to the osseus tis-

sues to respond to the fracture insult.

The problem become manifold particularly when a large part of bone is subcutaneous as in the leg. Further the leg is exposed to much more chance of injuries as most of the time, being the lowest part of the body. It becomes the commonest target of injury forces.

Thus the principles which guided Percival Pott are still valid today, with thorough debridement, adequate stabilization and soft tissue coverage forming the tripod of management of open fractures. Anti biotics and tetanus prophylaxis are the new additions.

Gustilo classified the open fracture on the basis of associated soft tissue injuries thus emphasizing their role in the prognosis and management of open fractures.

Successful management of compound fractures demand proper primarily evaluation of the fractures, familarity with wide variety of modern equipment and implant and knowledge of surgical technique.

17th century witnessed the development of varity of external fixation appliances made with steel and leather, but the progeny of present day fixation device was developed by Langenbact 1874 who in an attempt to solve the twin problems of bone and soft tissue damage deviced a new method of fixation using threaded pins, clamps and connecting rods.

Hoffman (1954) popularised this maethod of fixation all over Europe. At the same time Charnley using his compression device for arthrodesis confirmed the positive role of compression in union of cancellous bone.

From 1968 to 1970 Vidal and Audrey modified the Hoffman device from a single half pins unit to a quadrilateral bicortical plane thus greatly increasing the rigidity and expanding the indication of the use of the pin fixator.

Overzeoulous use of the fixator lead to its disrepute but it has resurfaced and is now a well accepted tool in the initial management of a communited compound fracture where internal fixation is impracticable. Amongst of external fixator devices, the AO external fixator has a better role and minimum complication.

Berhens gave nomenclature to different frame configuration of AO tubular external fixator and classified them as :-

* Unilateral one plane configuration
* Unilateral two plane configuration
* Bilateral one plane configuration
* Bilateral two plane configuration

The external fixator is at present accepted as a useful device as it provides rigid fixation in grade IInd and IIIrd open fractures and management of wound and soft tissue damage. It

provides early joint mobility obviating the triad of fracture disease and can if required be applied with an anaesthetist. The technique is easy, the assembly light and relatively cheap than ring fixator of Ilizarov. However it is known for its higher rate of pin tract infection with formation of ring sequestras and even fracture through pin insertion site.

The present study aims at evaluating the incidence of open fractures of the tibial shaft and the result of treatment using the AO tubular external fixator in the Bundelkhand region.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The management of fractures has enjoyed cyclical popularity. The oldest recorded evidence of fracture management came from the Egyptian dynasty some five thousand years ago. The Egyptians and Babylonians used splint for broken bones, whether this was based on knowledge of fracture healing or to reduced pain is not clear; they were also used olive oil, pigeon dung, snake oil and other essence, probably in an attempt to enhance fracture healing.

Sushruta (600 BC) the great Indian surgeon advised amputation for the severely injured limbs with compound fractures in an attempt to save the life of the patients. Early amputation of the limb for the compound fracture was a crude procedure in which the limb was rapidly severe in an unanaesthetised patient; for haemostasis the open stump was crushed or was dipped in boiling oil.

With passage of time Greece became the centre of world civilization and accordingly of medical knowledge which the most contribution from Greece was the Hippocratic corpus an apocyphical collection from medical writing and accumulated for over four centuries. Compound fractures were bathed with wine (antiseptic), infection in compound fractures was thought to be of "spontaneous generation".

First fracture of proximal humerus documented by Hippocates and describing a method of weight traction that aided in bone

healing. He recorded the number of observations about clavicles fractures and also recommended that close fracture of ankle be reduced by extension of foot however open fracture should not be reduced, or the patient would died from "inflammation" and gangrene within 7 days.

Hippocrates (3rd century BC) first used a crude external fixation device of padded rings about the knee and ankle using curved branches of tree for stabilization of fractures. His greatest contribution in this regard lay in his recognition that surgeons can only facilitate fracture healing, they can not enhance it.

Open fractures are surgical emergencies that perhaps should be thought of as incomplete amputation. Before 1916 open femoral fractures in the first world war lead to death in 80% of patients, although this incidence was reduced to 15.6% after more aggresive management, mainly the Thomas splint. ORR (1927) advocated antisepsis by wide drainge wound packing or plaster immobilization but did not advocated debridement. Trueta (1939) advocated debridement and stated that sepsis will not occur if all deviatalized tissues are removed.

Gustilo reported the commulative results of treatment at the Heinpevin Country medical centre between 1955-1984 with regard to sepsis in open fractures of 1846 patients. In patients in whom the maximum incidence of sepsis was in type III open fractures and there was no sepsis in type I open fractures. In 1984 report, Gustilo, Mendoza and Williams reported that wound

sepsis was a problem, premarily in type III open fractures and related to the soft tissue damage and periosteal striping. In these three subtypes infections rates were type dependent; type III a having a rate 4% while type III b&c had 52% and 42% respectively. Similarly the amputation rates for the three subtypes of type III fractures were 9%, 16% and 42% respectively.

Tscherne described the four eras of open fractures treatment; the era of life preservation, the era of limb preservation, the era of infection avoidance and the era of preservation of function. The first or preantiseptic era lasted well into the twentieth century. The era of limb preservation encompassed both World Wars but was marked by a high incidence of amputations and consequent improvement in artificial limb and prosthetic designs. Tscherne dates the era as lasting until the mid 1960s during which attention was focussed on the avoidance of infection and the use of antibiotics. According to him the present era of the era of preservation of function and he credits the obtaining of this goal to aggressive wound debridement, definitive fracture stabilization with internal or external fixation and delayed wound closure.

Stabilization of an open fracture generally should provide adequate stability thus minimizing further damage to the vascularity in the zone of injury and its associated soft tissues. For type I wounds, essentially any technique that is suitable for closed fracture management is satisfactory. Treatment of type II and III a wounds is more controversial with proponents of

traction, external fixation, nonreamed medullary nailing and occasionally plate and screw fixation.Generally external fixation is preferred for metaphyseal-diaphyseal fractures with occasional limited fixation with screws. For type III b and III c injuries that are salvageable external fixation is still the prefered treatment modality.

External fixation is a process of manipulating alinging and stabiliging the bony structures with pins or screws that affix the bone to external frame. In the 17th century a numerous varities of external appliances were being manufactured from steel and leather for treatment of various orthopaedic problems.

Langenbect (1874) was the first to use pins with threaded tips and described a fixator using pins held in clamps proximal and distal to the fracture site using clamps connected to a metal rod. Keetley (1893) designed an external fixator for fracture. He also reported the frequency of malunions in femur and recommended that rigid pins be inserted percutaneously and held in a special external fixation device.

First modern version of external fixator was developed by Clayton Parkhill of Denver (1898) and described the use of two half pins, above and two half pins below the fracture site in fracture of long bones joined externally by indigeneous clamp for reduction and immobilization.

Freiberg (1912), Lambotte (1912) and Humphry(1917) were probably the first to advocate the use of threaded pins that could

distract the fracture but they used only one above the fracture and one below the fracture site. Lambotte (1912) described four principles of surgical treatment of fracture, exposure of fracture, reduction of the fracture, provisional stabilization of the fracture and definitive stabilization of the fracture. Crile in 1919 advocated an external fixator particularly adapted for fracture of the femur associated with war wounds, but this technique gained very little popularity.

Abotte (1927) poppularised tibial elongation and used transfixaton with Steinmann pins and a device for slow distraction. His apparatus was further modified by several workers. He also noted the problem of soft tissue imbalance and performed a tendoachilis lengthening as a part of his technique. Conn (1931) modified the previously used external fixators described 15 excellent results in 20 patients, however, he reported frequent problems like pin tract infection. In 1931 Bosworth described a device for tibial lengthening. Pitkin C and Blackfield HM (1931) were the first to advocate pins inserted through both cortices and attached to the two external fixation clamps.

R. Anderson, Anderson and Burgess, Anderson and Finlayson, Andrson, McKibbin and Burgess and Anderson and O'Neil of Seattle during the preiod 1933-1945, presented a series of papers concerning the use of half pin and whole pin units for the treatment of open fractures of all long bones also for the arthrodesis and limb lengthning procedures.

From 1938-1954, Hoffmann of Switzerland presented a series of articles describing his method of external fixation, later numerous authors in Europe and Scandinavia subsequently reported excellent results in their seires. Kuntscher (1940) showed series of articles describing his method of external fixation, later numerous authors in Europe and Scandinavia subsequently reported excellent results in their seires. Kuntscher (1940) showed convincingly that osteosynthesis could be secured along the medullary cavity of long bone. He described longitudinal fixation by means of metal implant occupying the full length of medullary cavity.

Charnley in 1948, popularised his compression device to facilitate arthrodesis of joints and his technique rapidly became popular. In 1950 Denham in United States Armed Forces based his treatment on the theory that early ambulation in an appropriately applied plaster cast is a method which uniformly results in union in compound tibial shaft fractures.

In 1966 and 1974, Anderson and associates reported the use of transfixing pins incorporated into a plaster cast for the successful management of large series of tibial shaft fractures. Sarmiento (1967) used ambulation P.T.B. plaster cast as functional cast brace on a scientific basis. From 1968-1970 Vidal and Audrey modified the original Hoffmann device from a single half pin unit to quadrilateral bicortical frame, greatly increasing it's rigidity. These investigators greatly expanded the indications for use of external fixation.

In 1970, prompted by a surge of interest in external fixation, Giovanni De Bastiani of Verona, Italy, introduced an improved design, he called "dynamic axial fixator". De Bastiani's new design based on a unilateral robust frame, combined the simplicity and strength of Wagner's unilateral leg lengthning device with a telescopic, "dynamizable" fixator body.

Jorgensen, Olerud, Karlstrom and Olerud in 1971 further documented the usefulness of the technique in a variety of open, comminuted fractures and nonunions. They treated open tibial fracture by secondary intramedullary nailing after intial treatment with external fixation for 8-9 weeks. The average time between the removal of external fixator and nailing was three week. They found 50% rate of nonunion on the equally high rate (44%) of infection.

In 1976 , Gustilo classified the open fractures into variuos grading and this clssification was modified in 1984 by gustilo and Gruninger and Davis which is now widely accepted. The critical factors in their classification are -the degree of soft tissue injury and the degree of contamination. This modified classifications groups injuries into three grades.

Grade I : Compound fracture with clean wound less than one cm.

Grade II : Laceration of more than one cm without extensive soft tissue damage.

Grade III : This group is again divided into three subgroups.

A : Have extensive soft tissue laceration however maintains adequate soft tissue coverage for bone, they result from high energy trauma. This group includes segmental or severely comminuted fracture even those with one cm laceration.

B : Have extensive soft tissue loss with periostial stripping and bone exposure. They are usually grossely contaminated.

C : Open or compound fractures with neurovascular injury that requires repair regardless of size of wound.

Gustilo and Anderson in 1976 in a retrospective and prospective analysis on prevention of infection in the treatment of 1025 open fractures of long bones (managed by debridement and copious irrigation, primary closure for typr I and II fractures secondary closure for type III fractures no primary internal fixation except associated with vascular injuries) found an infection rate of 3-25%.

Lowyer & Lubbers in 1980 reported that healing of thirteen grad I open fractures in an average of 4.7 months using the Hoffman external fixator. Eight percent of the patients required secondary bone grafting. Of the ten type II open fractures three underwent early amputation, with the remaining fractures healing in an age of 8.8 month. In this group 71% of the patients required postero- lateral bone grafting, refracture occured in 43%, however union occured in this group with functional range

of movements.

A.J. Edge, R.A. Denham (1981) treated 38 patients with complicated tibial fractres by the Portsmouth method of external fixation. Twenty one of these patients had multiple injuries and thirty had compound fractures of the tibia. In eighteen fractures wound were infected. Seventeen cases required bone grafting 13 need skin grafting. Of these thirty eight patients in thirty four the fractures united in an average time of six months; three patients underwent below-knee amputation.

Kimmel (1982) reported treatment of 27 tibial fractures with Hoffman external fixator. He reported non-union rate of 13%, malunion in 39% and 45% required bone grafting.

In 1983 Gershuni D.H. and Halma G. reported the result of 29 patients presenting with type II and III open tibial fractures treated with A.O. external fixation device. Fractures with excellent reduction were treated in the frame with an average healing time of 2.5 months. The time being longer in those fractures with incomplete reductions in whome the fracture was primarily stabilized in the frame for less than 3.5 months and later by a cast. However, the cast group tended to have a higher rate of malunion. Interfragmentary screws were used to increased the fracture stability.

Gershuni and Halma (1983) treated 29 patients of type II,III open tibial fractures with A-O external fixator. Three patients required early amputation, 35% of the patients required autogeneous

bone grafting, 15% plate fixation, 8% of fractures did not unite. Twenty three percent of the patients developed pin tract infection, 38% deep wound infection and in four refracture occured. Union occured faster when fixator was removed in less then 3.5 months and cast applied but rate of malunion was higher than in those treated in frame.

De Bastiani Roberto Aldegheri L.R. BRIVIO (84) treated 288 patients with fresh fractures and 50 patients with ununited fractures with a Dynamic Axial Fixator. The Success rate for fresh fractures was 94% with an average healing time was 3.4 to 6.5 months. In ununited fractures the success rate was 94% with an average healing time was 4.7 to 6.5 months.

Court Brown and associates (1985) in a review of 51 type II open fractures treated with the Hoffman external fixation system, they found that type III A fractures required an average of 26 weeks to heal ,50% of the fractures required bone grafting and 10% required flap coverage. Fifty five percent of the patients returned to full activities after 2 years. Average time in external fixation was 9.7 weeks and malunion occured in 30% of cases. Type III B fractures required average of 47 weeks to unite with 17% of fractures required amputation, 78% required bone grafting and 57% required flap coverage. Mean duration of external fixation was 12 weeks. Malunion occured in 71% of cases, Ostomylitis in 35% and pin tract infection in 50%. Full recovery occured in the two years. Twenty eight percent of the type IIIC injuries resulted in amputation.

Behrens and Searles in 1986 reported successful treatment of 75 fractures with A-O external fixator, 80% of which could be treated with a unilateral uniplaner fixator. Bone grafting was done in 67% of the fractures, pin tract infection occured in 12% of patients and refracture in only one patient.

In 1987 Alonso JE; Horowitz M in their study in United States, treated 16 children with 20 fractures using the AO/ASIF external fixator. Most of the fractures were open,,but the fixators were also used in closed fractures in children with head injuries. This series included ten fractures of the tibia, five of the femur, three of the pelvis and two involving the humerus. Average follow up was 26 months with the fixator left in the place for an average of 7 weeks. Fracture union occured after an average of 16 weeks.

Burgess et al (1987) reported 74% decrease in time of union (from 58.4 weeks to 37.6 weeks) for type III open tibial fracture during the evalution of their protocol. They recommended debridement, copious pulsed lavage, scheduled repeated debridement every 24 hours, judicious use of internal fixation, early grafting or free flap coverage of the soft tissue defects, anterior half pin external fixation, early prophylactic bone grafting by 3 to 4 weeks after injury and gradual disassembly of the external fixator frame.

Mc Graw et al (1988) treated open tibial fracture with external fixation and secondary intramedullary nailing and said

that secondary intramedullary nailing prevented the complication of external fixation like refracture, loss of reduction and malunion. However these gains were at the expense of increased incidence of infection and of delayed healing of the fracture.

In another series, Green, More and Spohn (1988), reviewed 72 nonunoin of tibial shaft and found that 76% were open fractures and 51% were infected. They believed that the development of nonunion probably was related more to soft tissue injury that to the method of initial treatment. Complications were frequent in their patients. Sixty one percent had angulation of more than 5 degree at the end of treatment and 12.9% had aseptic nonunions.

Halbrook J.L., Swionkowski M.F. and Sanderl R. (1989) undertaken a randomized prospective study comparing the Ender's nailing with external fixation for open fracture of 63 patients. Ender's nailing is a safe alternative to external fixation for grade I and II open fractures. It should not be used for comminuted fracture.

Blachunt PA, Meek RN and Brien PJ (1990) treated 41 fractures of tibial shaft with debridement and provisional external fixation, followed by delayed soft tissue closure and subseuqent intramedullay nailing with reaming. This sequential protocol for treatment, which involved a short period of external fixation and thus minimised colonization of the pin tracts, yielded excellent results and a low rate of infection.

Jin Y, Meno Haung H (1991) published the results of their

study of 1033 cases from 1977-1987 of unstable both bone fractures of leg treated with external fixator designed by the author. Two hundred and thirty two were open fractures and all the patients were followed up for four to 90 months (average 20 months). The duration of bed confinement averaged 8.3 days and the mean time necessary for clinical bone union was 54 days. Anatomical or nearly anatomical bone apposition was achieved in 878 cases (85%), functional apposition in 141 (13.6%) and malunion in 14 (1.4%). The overall functional results were as follows : excellent in 769 (74.4%), good in 218 (21.1%), fair in 32 (3.1%) and poor in 14 (1.4%).

Heim D, Marx A, Hess P, Schlapfer R and Regazzoni P at Kantonsspital Basel (1991) in their study stated that the initial treatment of choice for fractures with severe soft tissue damage of the leg is the stabilization with an external fixator. After successful healing of soft tissue they probed the allertness to continuing the initial treatment with external fixator till union and replacing the initial stabilization by an internal fixation device. Their experience with 62 fractures of the tibia (a follow up of 59 fractures) from 1985 to 1989 showed that 72% of the fractures healed by continuing external fixator it self. Delayed union or pseudo-arthrosis occured in 17% and were mostly the cases treated by late internal fixation. An analysis of the fracture types (using the AO classification) did not point out particular fracture types that did not respond to the external fixator treatment alone thus they concluded that the cause for a delayed union

or pseudoarthrosis was less a morphological and more a biological one. It was recommended that the external fixator be used as a first and final stabilizer for fractures of bones of leg with severe soft tissue damage.

Dagher & Roukoz (1991) treated the nine patients with severe compound tibial fractures with average bone loss of 6.3 cm by Ilizarov technique all nine patients had satisfactory union and function without the use of bone graft.

Fischer and associates (1991) have noted an increased success rate and lower infection and nonunion rate with early application of soft tissue free flap coverage compared with delayed coverage. They have also related this to earlier bone grafting that increased rate of union with decreased time to healing.

Masbah O, Noor M.A. (1992) in their study at Kebangsaan, Malaysia published the results of treatment using locally designed external fixator in 20 cases. Open fractures were the main indication for external fixation. Pin tract infection occured in eight patients. Only two patients had unstable fixation which required removal of the device. One third of patients developed malunion exceeding 15 degrees and two thirds had joint stiffness after conversion to plaster cast. This external fixator was reported adequate in the treatment of open fractures of the tibia. However improved technique of pin insertion and cast application upon removal of the external fixator has helped to reduce the incidence of pin tract infections and malunion.

Wu and Co-workers (1993) treated 28 open distal tibial fractures with primary external fixation and secondary closed Grosse-kempt inter locking nail after two weeks. All fractures were of the type III B and local soft tissues coverage was performed after 3-5 days. The result revealed a union rate of 85% with in an average of 5.8 months. Complicatons were 14.3% non union and 7.2% deep infection rate. This study suggested a time dependent relationship on conversion of external fixation to reamed nailing.

Georgiadis GM, Behrens FF and Joce MJ et al (1993) compared the limb salvage with below knee Amputation for open fracture with severe soft tissue loss. The patients treated by limb- salvage proceedure took more time to achieve full weight bearing , less able to work & higher hospital charges than the patients who had been managed with a below knee amputation.

P. Tornetta & co-workers (1994) reported early results of randomized, Prospective study comparing external fixation with non reamed locking nails in grade III B open tibial fractures and considered that locked non reamed nailing is treatment of choice for grade III B open tibial fractures.

Richardson and co-workers (1994) measured fracture stiffness in 212 patients with tibial fractures treated by external fixation and considered that a stiffness of 15 nm/ degree in segital plane provides a useful definition of union of tibial fractures.

Tripathi et al (1995) in their study of 20 cases of open

fractures of tibia treated by debridement and fixation with AO tubular external fixator. They reported delayed union in 45% of cases, nonunion in 15%, pin tract infection in 40% . The results of their series were assessed as excellent (45%), good (20%), fair (15%) and poor (20%).

Howard M, Court Brown CM (1997) at Edinburgh gave epidemiology and management of open fractures of the lower limb. Their epidemiological analysis indicated that 40% of open fractures occured in the lower limb and tibial and femoral diaphyses were most commonly affected. Recent advances in fracture stabilization and soft tissue reconstruction technique have improved the outcome of these fractures.

MATERIAL AND METHODS

MATERIAL AND METHODS

The study was conducted in the department of Orthopaedics, M.L.B. Medical College Jhansi.

The patients for this study were selected from those attending the out patient department of Orthopaedics and from those arriving at emergency department of M.L.B. Medical College, Jhansi.

All the patients were subjected to detailed history, clinical examination and necessary radiological and pathological investigation.

METHOD

Pre-operative evaluation of patients

History

Name, Age, Sex, Side of fracture, duration of injury, mode of injury, any other associated injury, concurrent or past history of major illness.

Clinical assesement of patients.

General condition, pulse, blood pressure, examination of cardiovascular system and respiratory system of patients for fitness for anaesthesia.

Local Examination

Examination for associated neurovascular involvement and associated injuries.

Radiological investigation

To assess the type of fracture and bone loss.

Routine investigation

It included blood Hb gram%, TLC, DLC, ESR, Blood sugar, Blood urea, Serum creatinine, ECG and X-ray chest P.A. view in relevant cases.

Initial Management

First Aid given to the patients in the form of thorough cleaning, primary debridement and sterile dressing of wound. Fracture stabilized with wooden splint and X-ray of affected limb was done in antero-posterior and lateral view. Prophylactic broad spectrum antibiotics, anti inflammatory and analgesic drugs were prescribed. Immunization against tetanus and gas gangrene was done. Whole blood transfusion was given to the patients who had severe blood loss.

Implant and Instruments

For the external fixation of open fracture of tibial shaft following basic instruments were used.

(A) Basic components of external fixator

* Schanz pin : Cortical pin of 4.5mm core diameter.
  Cancellous pin of 6.5mm core diameter.
* Denham pin : Of 4.5 to 5.5mm core diameter.
* Universal connecting clamp :

  Single pin universal clamp was used to connect Schanz

screw to stainless steel tubular rod.

* Tubular rod :

  This rod has out side diameter of 11mm and inside diameter of 9mm and vary in length from 100 to 200mm.

* Removable compression apparatus.

(B) Additional component of A.O. external fixator.

* Open single clamp
* Double pin clamp
* Tube to tube clamp :

  This clamp was used to connecting the two frame in different plane with the help of connecting rod.

* Transverse clamp

Special Instruments

1. Triple trocar with cannula.
2. Drill bit : 3.2mm in diameter extra long
   4.5mm in diameter extra long.
3. Drill
4. Tape : 4.5mm in diameter extra long with tape handle :
   6.5mm in diameter extra long with tape handle.
5. T. handle with chuck.
6. Spanner with T wrench
7. Depth gauge.

General Instruments

* BP handle with surgical blade No. 23.

* Artery forceps.
* Bone holding forceps.

Technique

* Spinal or general anaesthesia was given to the patients.
* Patients were placed on operation table in supine position.
* Part was cleaned, painted and drapped.
* Thorough debridement and irrigation of wound was done.
* Reduction was achieved by manipulation.
* A stab incision was given to the skin just two cm away from the adjacent joint.
* Triple trocar and cannula were inserted through this skin incision, just stabilize the cannula over the surface of bone.

  Trocar withdrawn then both corteces were drilled by 3.2mm drill bit through canula then canula also withdrawn. After taping with 4.5mm tape a 4.5mm cortical Schanz pin was inserted. In cancellous area of bone the cortex was drilled with 4.5 mm drillbit and after taping with 6.5mm tape a cancellous Schanz pin of 6.5mm was inserted.
* After insertion of initial Schanz pin the tubular rod was fitted with regard number of clamps.
* Fracture was reduced manually and second Schanz pin was inserted into other fragment near joint through farthest opposite

adjustable clamp. Reduction was required by tightening the most proximal and distal clamp.

* At this stage, great care was taken to secure proper length and rotational alingment before tighting of these two clamps.

* Insertion of remaining Schanz pins were done through the adjustable clamps. Schanz pins adjacent to fracture site were inserted two cm apart from fracture site.

* Nuts of clamps were tightened with spanner or T. wrench.

* Wound was cleaned with savelon and dressed with betadine and metrozyl ointment.

* Pins were dressed with sterile gauge soaked in betadine solution.

Post Operative Care

i. In post operative period, limb was elevated with the help of pillow.

ii. Radiograph

Post operative final position of pins and alingment at fracture site were checked radiographically. Readjustment was done if needed followed by monthly radiographs to assess the progress of union.

iii. *Active Physiotherapy*

Active exercise of adjacent joints and muscle strengthening exercise were started earliest as the pain permitted and

full range of active movements were encouraged.

iv. *Care of pin site*

Regular cleaning with spirit and application of sterile gauge soaked in betadine.

v. *Ambulation*

Non weight bearing ambulation with cruches was started when general condition of patient has recovered.

Weight bearing was allowed after consolidation of fracture radiologically. At discharge, care of pin site was explained, active physiotherapy, walking with cruches continued depending upon stability of fracture.

Follow up visits

Patients were followed up monthly depending upon desire objective and patients cooperation.

Patients were observed for any superficial infection, movements around adjacent joints, degree of pain and weight bearing status and radiograph in antero- posterior and lateral view to know progress of union and occurence of any deformity.

Planning of fixator removals

1. *Clinically*
   (a) No pain, tenderness and abnormal mobility at fracture site.
   (b) Status of wound healing.

2. *Radiologically*

Progress of union at fracture site was assessed radiologically.

Post Removal Care

1. Plaster immobilization in the from of above knee cast or PTB cast and weight bearing was allowed depending upon consolidation of fracture.

2. Active joint motion and muscle strengthening exercise were advised.

Analysis

The data were collected and evaluated subjectively, objectively and radiologically.

Subjective evaluation of result

Good : Normal function, no deformity, no pain, ambulation without support, no stiffness.

Fair : Mildly restricted function but routine activities were not disturbed, mild deformity, tolerable pain, mild stiffness at adjacent joint but useful function possible, ambulation with stick.

Poor : Grossely restricted motion and marked deformity, severe pain, marked stiffness and ambulation with cruches.

Objective evaluation of results

Good : No tenderness at fracture site, movement of, knee and ankle in normal limit, muscle wasting <1.0 cm, no in-

fection/ induration at pin site and no limb descrepancy.

Fair : Mild tenderness at fracture site, movement of knee and ankle joints slightly restricted, muscle wasting one to two cm, superficial infection/ induration at pin site, shortening of limb less than one cm.

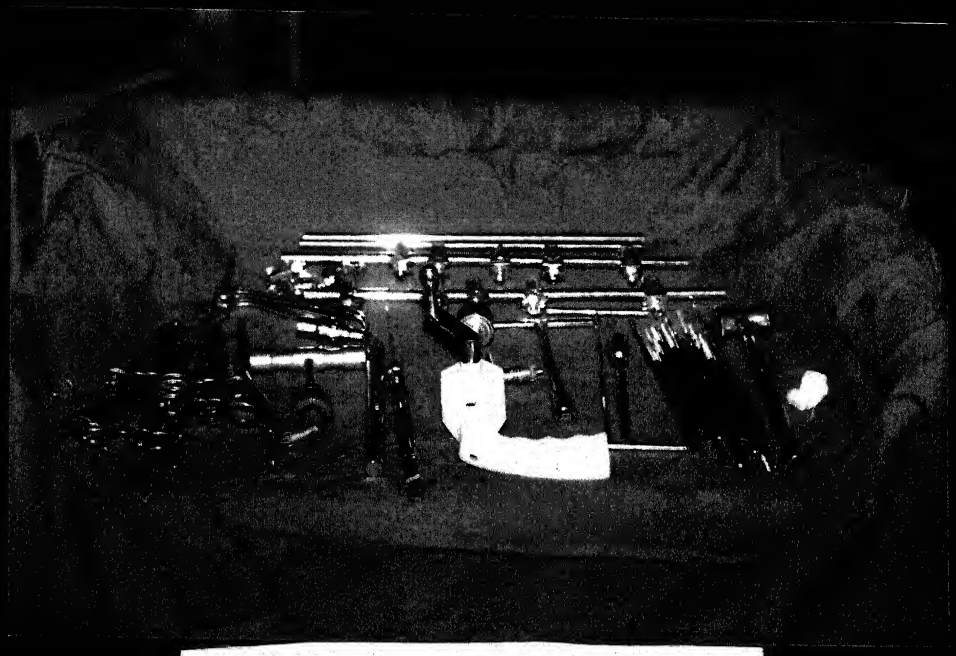
Poor : Moderate to severe tenderness at fracture site, movement, knee and ankle joint were restricted, muscle wasting more than two cm, deep infection at pin site and of shortening of limb more than one cm.

Radiological evaluation of results

Good : Good alingment and good amount of callus at fracture site.

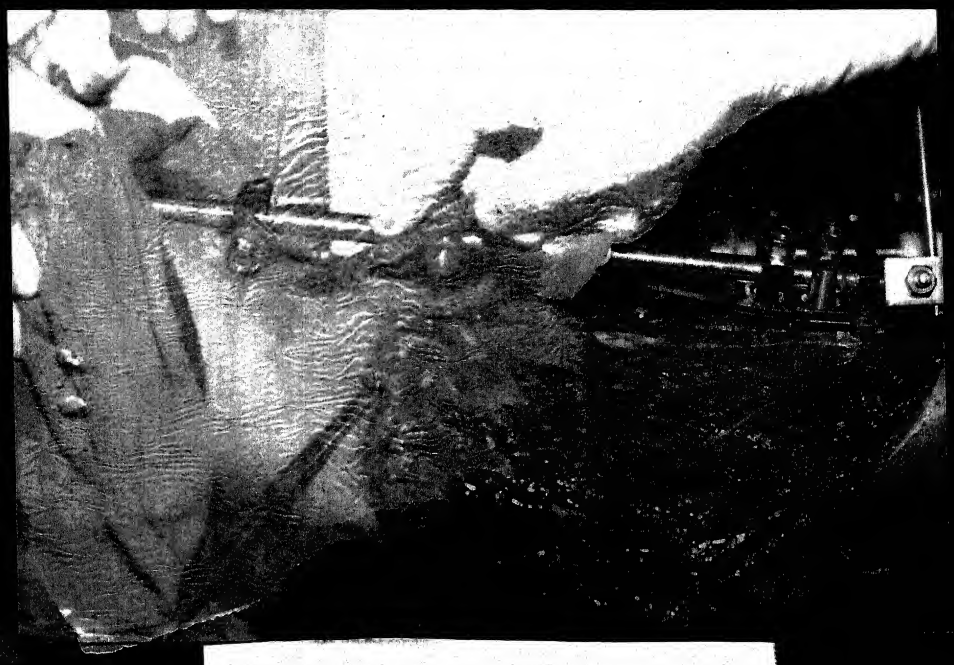
Fair : Acceptable alingment and fair amount of callus at fracture site.

Poor : Poor alingment and poor amount of callus or no callus at fracture site.

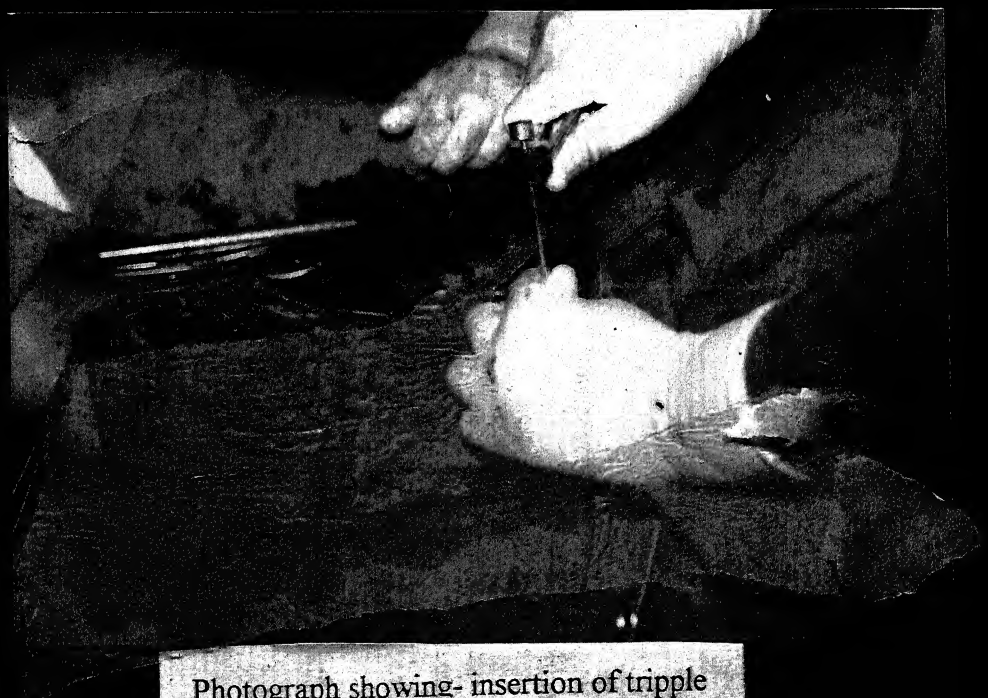


Implant and instruments of external fixator

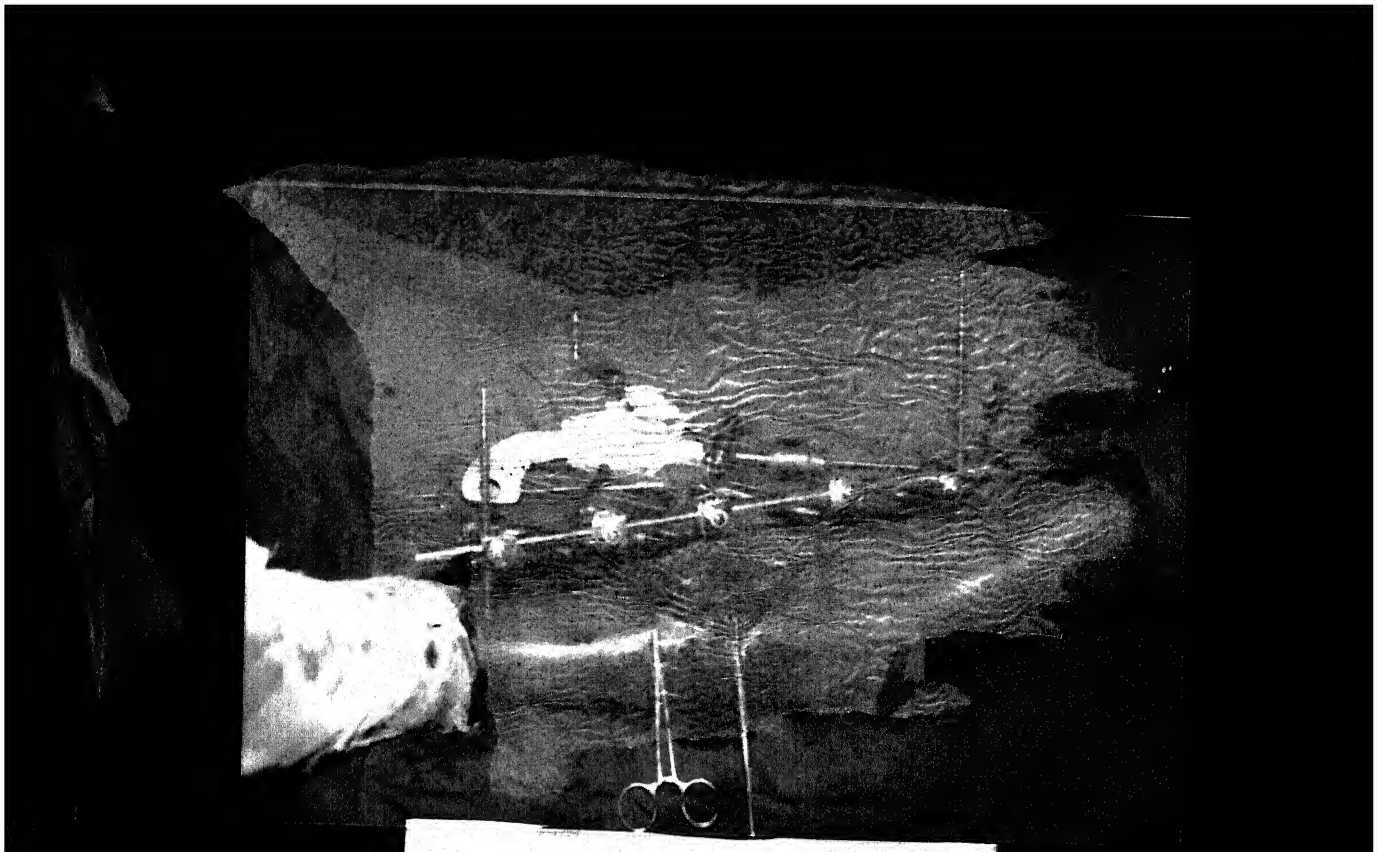
Photograph showing- the debridement of wound



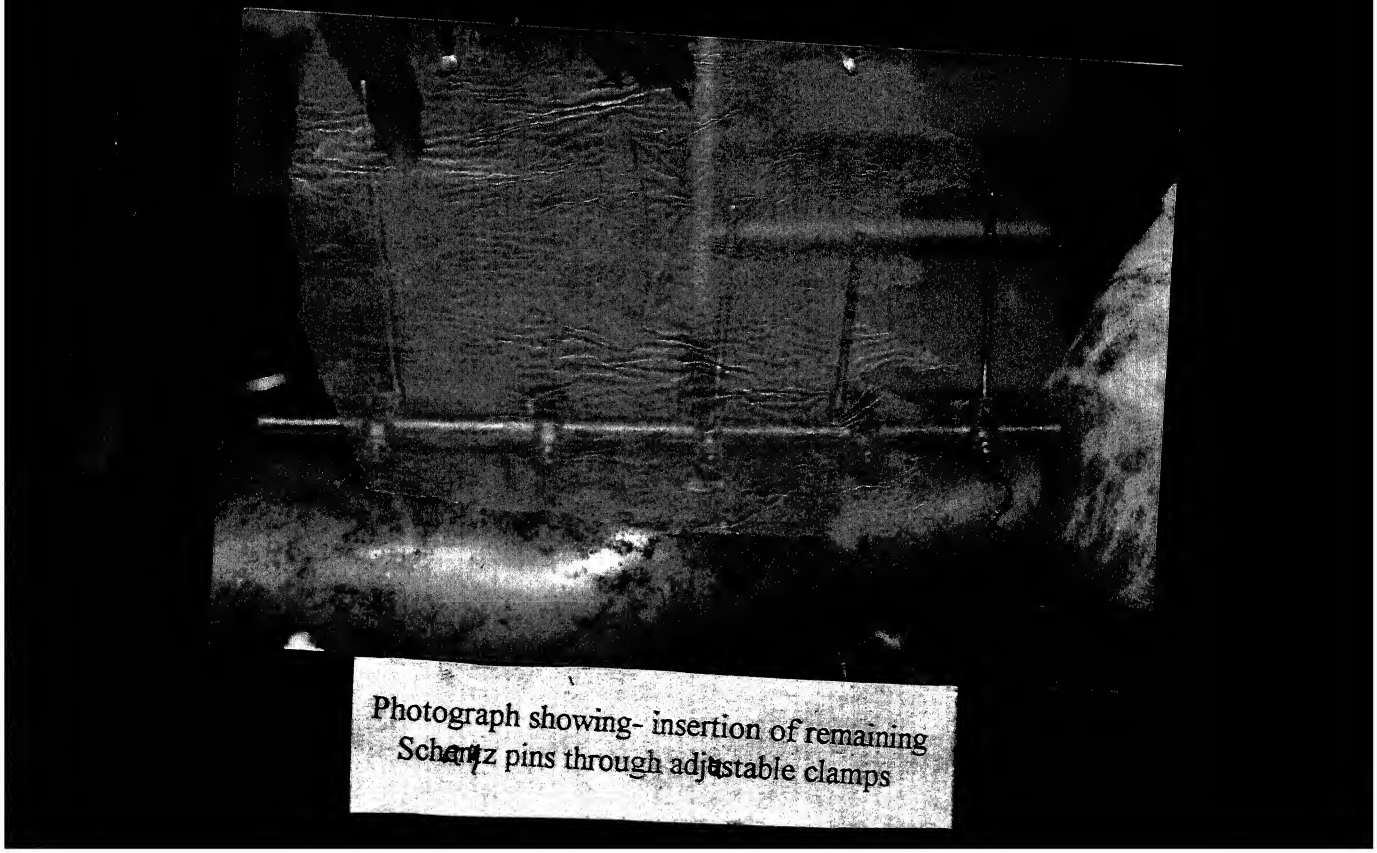
Photograph showing- stab insicion given by knife



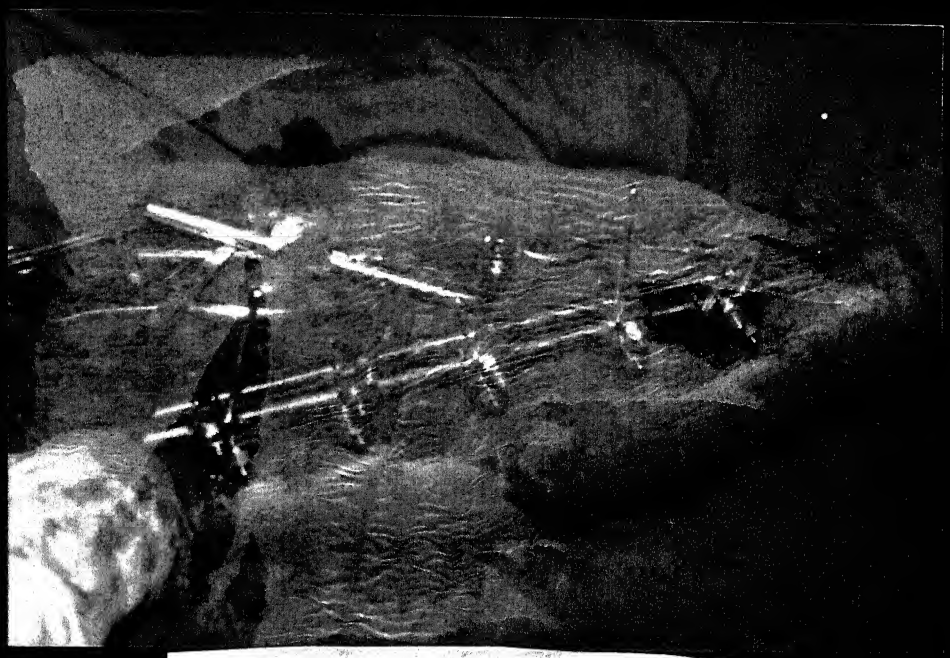
Photograph showing- insertion of tripple trocar through stab insicion



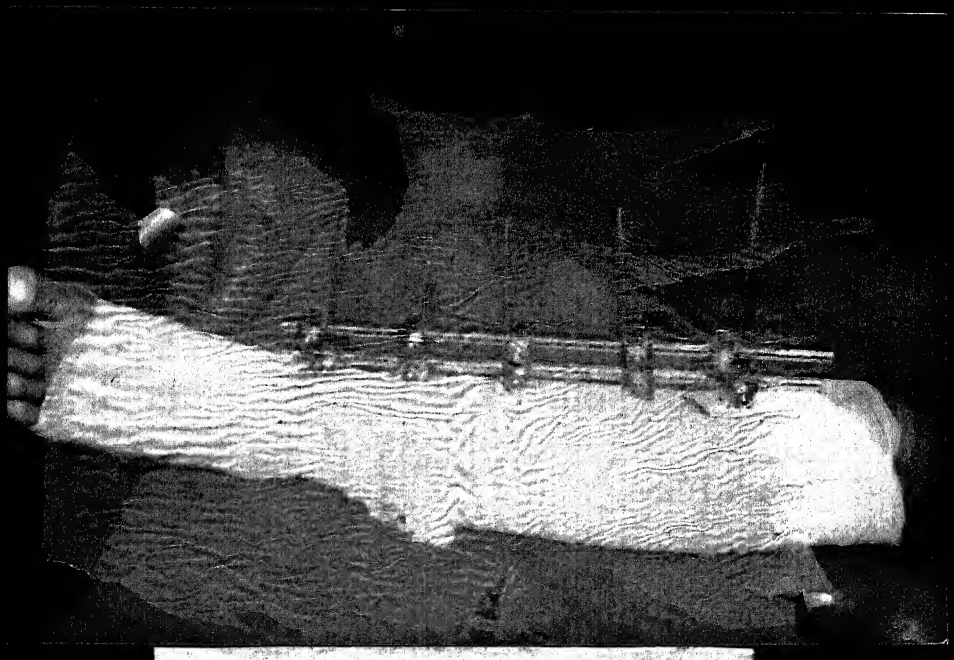
Photograph showing- insertion of second Schanz pin near proximal joint in farthest opposite adjustable clamp



Photograph showing- insertion of remaining Schanz pins through adjustable clamps



Photograph showing- fitting of second tubular rod in mirror image



Photograph showing- final position of the limb

OBSERVATIONS

OBSERVATION

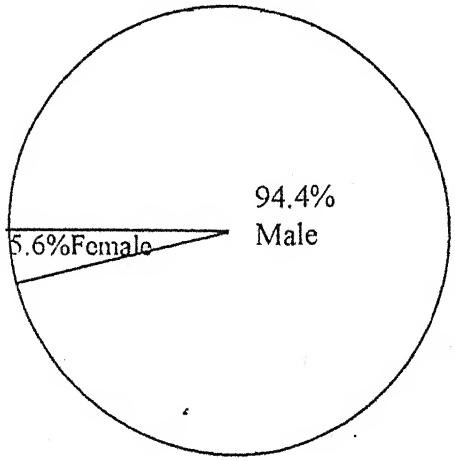
The study was conducted on 18 cases of open fractures of the tibial shaft, admitted in the department of Orthopaedics, M.L.B. Medical College, Jhansi. The study was conducted to evaluate the results of external fixation in the open fracture of tibial shaft using the AO external fixator.

TABLE I

Showing the incidence of injury in different age groups

Age group (Years)	No. of cases	Percentage
10-20	3	16.67
21-30	6	33.34
31-40	4	22.22
41-50	3	16.66
51-60	2	11.11
Total	18	100

The above table shows that maximum patients were in the age group 21-30 years accounting for six (33.3%) cases followed by four (22.2) in the age group 31-40 years.



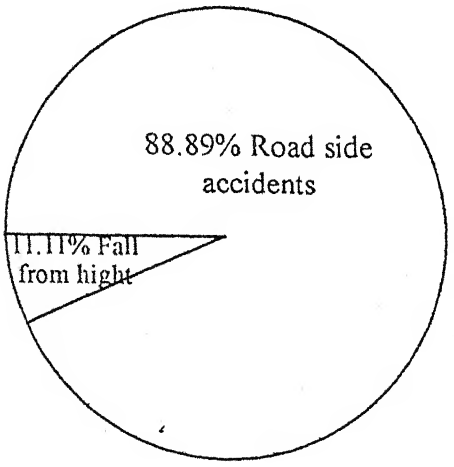
Pie diagram showing the sex distribution.

TABLE - II

Showing the occupation of patients

Occupation	No. of cases	Percentage
Farmers	7	38.89
Industrial worker	4	22.2
Office worker	2	11.11
Buisness man	2	11.11
Student	3	16.67
Total	18	100

Maximum patients were agriculture group accounting for 38.89%.



Pie diagmam showing the mode of injury

TABLE - III

Grade of injuries

(According to Anderson and gustilo classification)

Grade (Gustillo)	No. of cases	Percentage
Type I	2	11.11
Type II	7	38.89
Type III	9	50.00
Total	18	100

The maximum number of cases (50%) were of type III compound fractures followed by seven (38.89%) having type II compound fracture.

TABLE - IV

Incidence of associated injuries

Associated injuries	No. of cases	Percentage
No associated injury	11	61.12
Fracture of other bones	5	27.77
Nerve injury	2	11.11
Other injuries	0	00.00
Total	18	100.00

Table IV shows that 11 (61.12%) cases had no associated injury while five (27.77%) cases had multiple fractures and two (11.11%) cases nerve (peroxeal) injury.

TABLE - V

Showing type of fracture

Type of fracture	No. of cases	Percentage
Stable	10	55.57
Unstable	8	44.43
Total	18	100.00

Table V shows that stable fractures are more unstable fracture.

TABLE - VI

Bacteriological study

Type of oraganism	Sensitivity	No. of cases	Percentage
Prtoeus and E.coli	+++Cefotaxime +++Amikacin ++Gentamycin ++Ciprofloxacin	5	27.77
Pseudomonas and E.coli	+++Cefotaxime +++Amikacin ++Gentamycin ++Ciprofloxacin	3	16.67
Proteus	++Cefotaxime ++Ampicillin ++Ciprofloxacin ++Norfloxacin	3	16.67
E.coli	++Ciprofloxacin ++Gentamycin ++Netilmycin	2	11.11
Staphylococcus aureus	++Amikacin ++Ceftriaxone + Lincomycin	1	5.55
No organism		4	22.23
Total		18	100

Most patients had mixed infection. However in four (22.23%) cases no organism could be grown.

TABLE - VII

Time of application after admission

Time interval application of fixator after admission	No. of cases	Percentage
With in 24 hr	12	66.67
24-48 hr	4	22.23
48-36 hr	1	5.55
36 hr - 1 week	1	5.55
Total	18	100

The maximum number 66.67% of cases were treated by debridement and external fixator with in 24 hr after admission while in 22.23% 24-48 hrs.

TABLE - VIII

Configuration of external fixator used

Fixator configuration	No. of cases	Percentage
Unilateral uniplanar	6	33.33
unilateral biplanar	9	50.00
Bilateral uniplanar	3	16.67
Bilateral biplanar	--	----
Total	18	100.00

In nine (50%) cases unilateral biplanar external fixator was applied. In six (33.34%) cases unilateral uniplaner double rod (in mirror image) external fixator was applied and in three cases only bilateral uniplanar fixator was applied.

Bar chart showing the duration of external fixator used

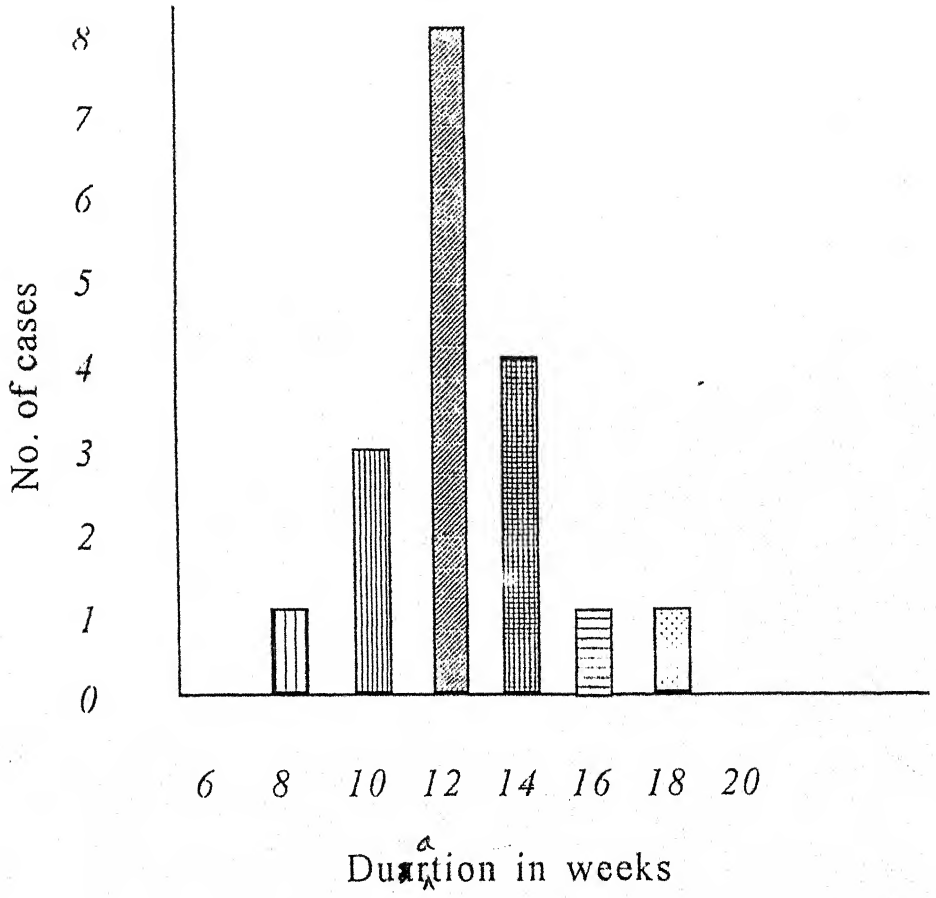


TABLE - IX

Procedure supplementing the external fixator

Type of procedure	No. of cases	Percentage
Skin grafting	8	44.44
Bone grafting	4	22.23
Sequstrectomy	1	5.55
No procedure	5	27.78
Total	18	100.00

Table IX shows that skin grafting was done in eight (44.44%) cases, bone grafting in four (22.23%) and sequestrectomy in one case.

TABLE - X

Plaster immobilization after removal of fixator

Type of plaster	No. of cases	Percentage
Above knee cast	15	83.34
PTB cast	3	16.66
Total	18	100

Table X shows that in most cases above knee cast were applied. Only in three cases PTB cast was applied just after removal of fixator.

TABLE XI

Average duration of plaster immobilization

Type of fracture	Time (in weeks)
Type I	14
Type II	15
Type III	27.77

Table XI shows that average duration of plaster immobilization after fixator removal was type dependent. It was more in type III than type II and I.

TABLE - XII

Showing the complications

Complications	No. of cases	Percentage
Pin tract infection	5	27.78
Joint stiffness	2	11.11
Osteomyelitis	1	5.55
Delayed union	2	11.11
Non union	2	11.11
Uncomplicated	6	33.34
Total	18	100.00

Table - XII shows that pin tract infection is the main complication of external fixator which occured in five (27.78) cases followed by joint stiffness.

TABLE - XIII

Showing time in weeks for union

Type of fracture	Time (in weeks)
Grade I	23.50
Grade II	26.50
Grade III	33.70

Table XIII explained that healing of open fractures of open tibia depend upon amount of soft tissue injury and periosteal stripping.

TABLE - XIV

Subjective evaluation of results

Subjective criteria	No. of cases	(%)
Function and appearance		
(a)Normal function and no deformity	14	77.79
(b)Mildly restrictive function, Routine activities are not disturbed and mild deformity	3	16.66
(c)Grossly restricted function and marked deformity	1	5.55
Pain		
(a)No pain	13	72.23
(b)Tolerable pain	4	22.22
(c)Severe pain	1	5.55
Stiffness of adjacent joint		
(a)No stiffness	12	66.67
(b)Mild stiffness	5	27.78
(c)Marked stiffness	1	5.55
Ambulation		
(a)Ambulation without support	13	72.23
(b)Ambulation with stick	4	22.22
(c)Ambulation with crutches	1	5.55

Table XIV shows that subjective good results were observed in average of 13 (72.23%) cases, fair results in average of four (22.22%) cases and poor results in only one (5.55%) case.

TABLE - XV

Objective evaluation of results

Objective criteria		No. of case.	(%)
Local tenderness at fracture site			
(a) No tenderness		14	77.79
(b) Mild tenderness		3	16.66
(c) Moderate tenderness		1	5.55
Range of movements at adjacent joint			
(a) Knee joint	(i) No stiffness	15	83.34
	(ii) Moderate stiffness	2	11.11
	(iii) Severe stiffness	1	5.55
(b) Ankle Joint	(i) No stiffness	13	72.23
	(ii) Moderate stiffness	3	16.66
	(iii) Severe stiffness	2	11.11
Status of pin site			
(i) No infection / induraion		13	72.23
(ii) Superficial infection		4	22.22
(iii) Deep infection		1	5.55
Limb length descrepancy			
(i) No descrepancy		16	88.89
(ii) Shortening <1		2	11.11
(iii) Shortening >1cm		00	0000

Table XV shows that objective good results were observed in average of 13.6 (75.92%) cases, fair in 3.5 (19.44%),a nd poor in 0.9 (4.64%) cases.

TABLE - XVI

Radiological evaluation of results

Radiological criteria	No. of cases	(%)
(1) Alingment of fracture site		
(a) Good alingment at fracture site	14	77.79
(b) Acceptable alingment at fracture site	3	16.66
(c) Poor alingment at fracture site	1	5.55
(2) Progress of union		
(a) Good amount of callus at fracture site	14	77.78
(b) Fair amount of callus at fracture site	2	11.11
(c) Poor amount of callus at fracture site	2	11.11

Table XVI shows that radiological good results observed in 14 (77.79%) cases while average in 2.4 (13.85%) and poor in 1.5 (8.33%).

TABLE - XVII

Final result of 18 cases of open fracture of tibial shaft

Result	Average of subjective result	Average objective result	Average radiological result	Overall
Good	72.23	75.92	77.79	75.32
Fair	22.22	19.44	13.88	18.51
Poor	5.55	4.64	8.33	6.17
Total	100	100	100	100

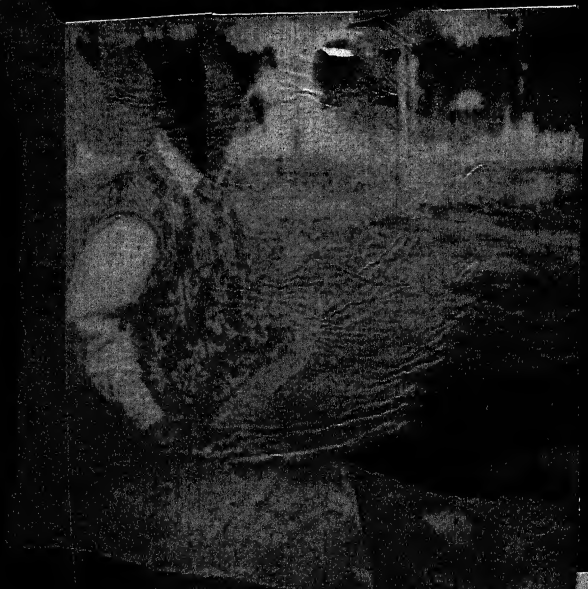
Table XVII shows that out of 18 cases of open fracture treated by external fixator, overall average good results were obtained in 75.32% of cases, fair results in 18.51%, however, poor results were obtained in 6.17 of cases.

Photograph showing- full weight bearing

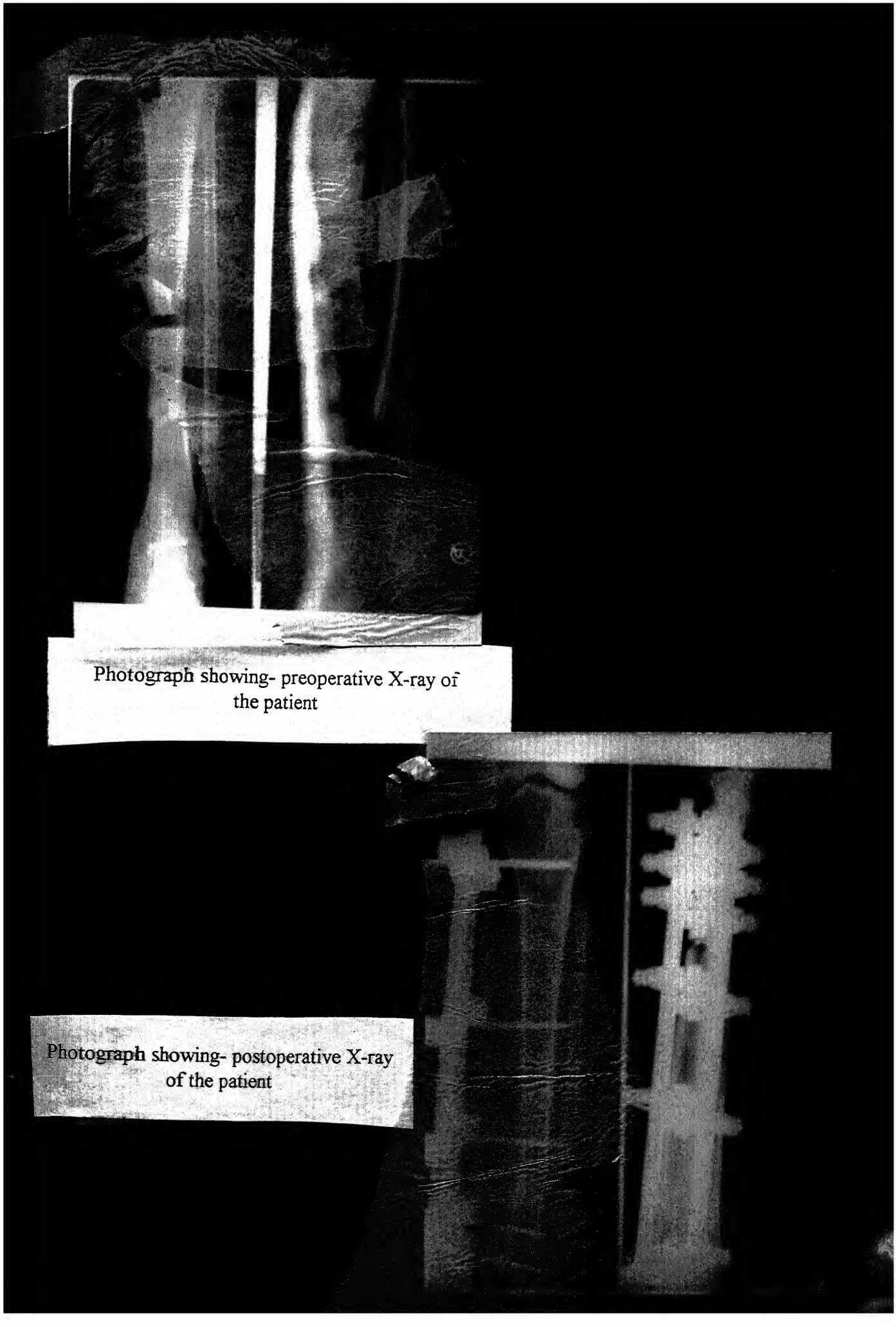
Photograph showing- full flexion at the knee joint

Photograph showing- squatting position of the patient

Photograph showing- planter flexion at the ankle joint



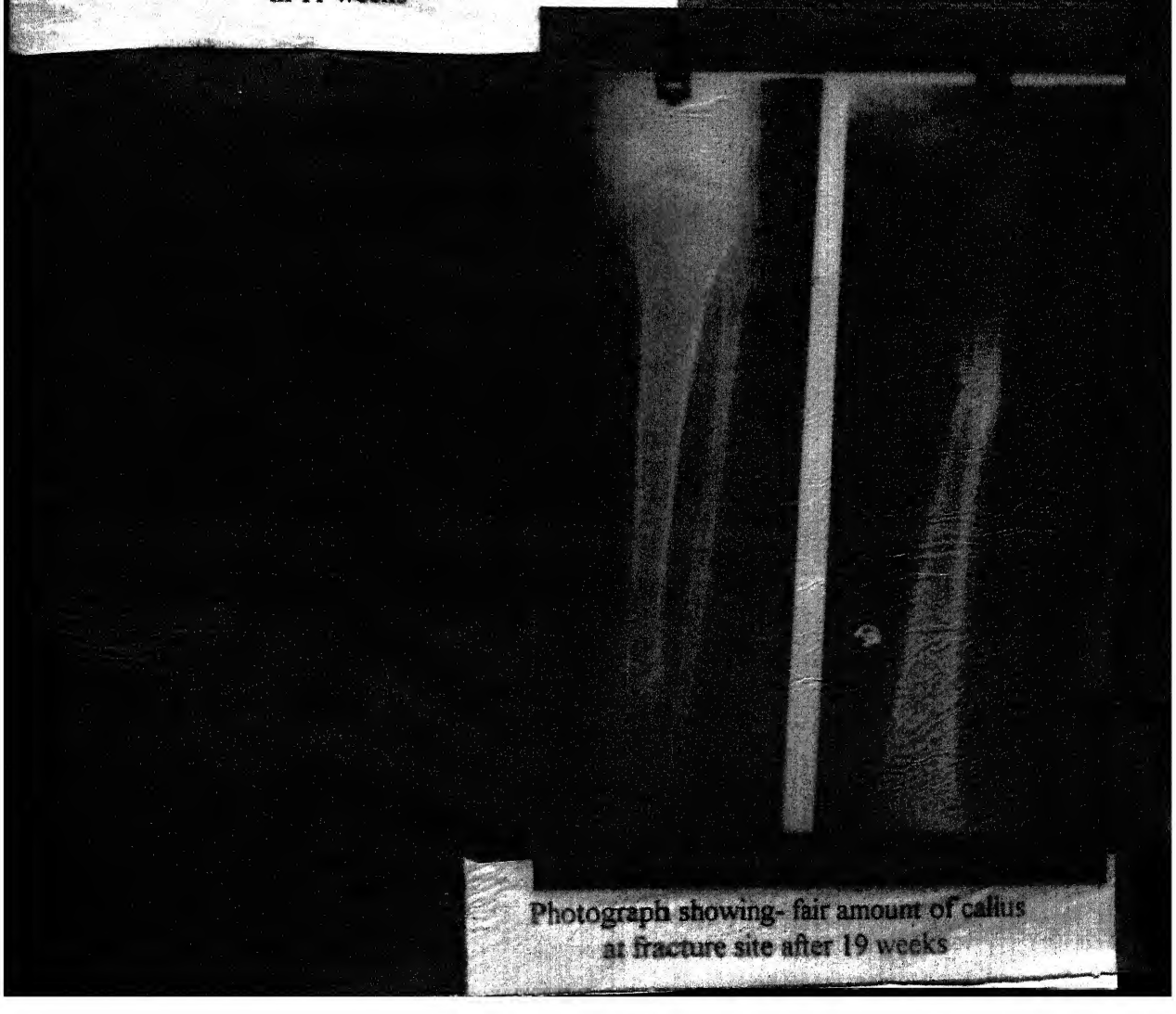
Photograph showing- dorsi flexion at the ankle joint



Photograph showing- preoperative X-ray of the patient

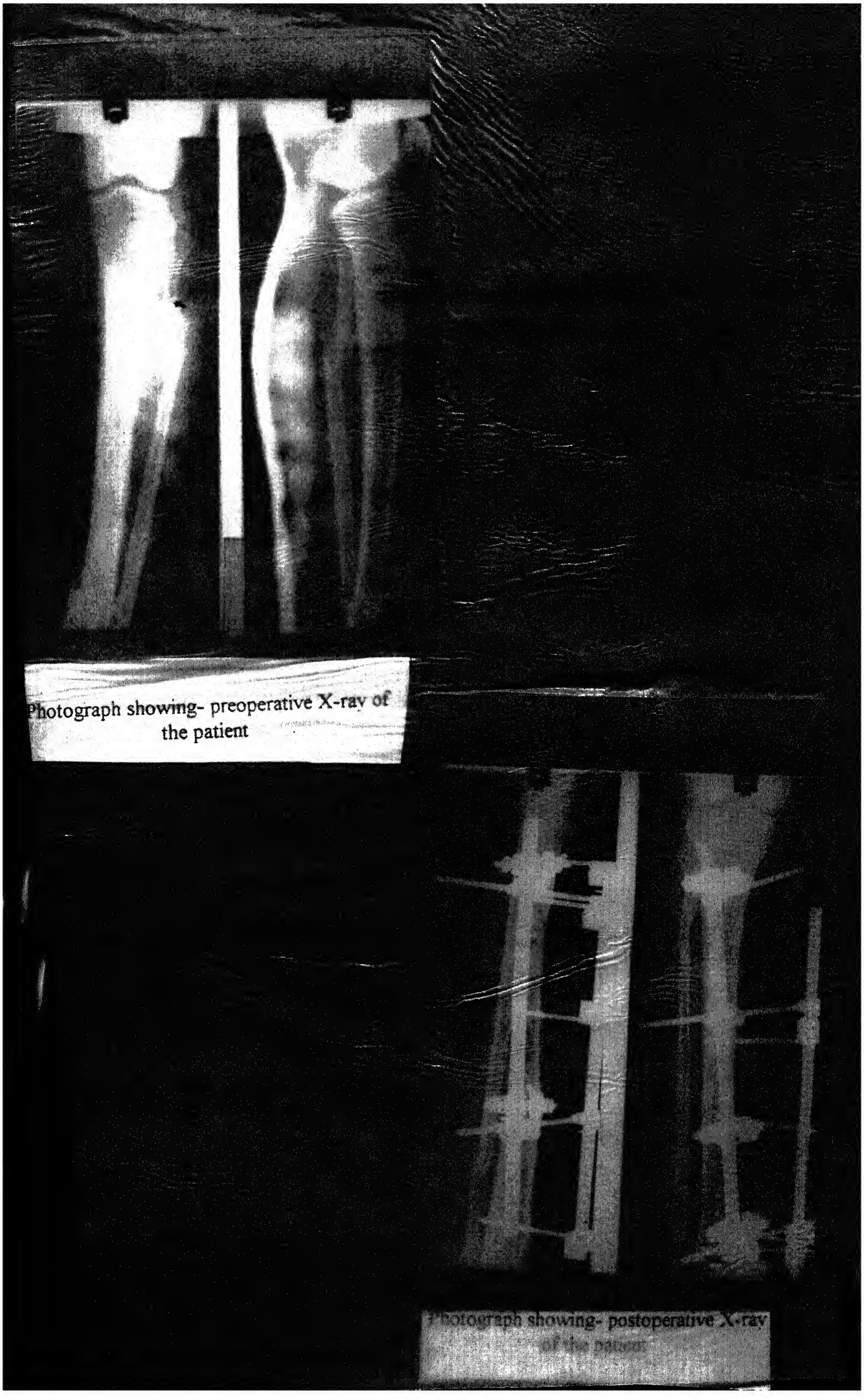
Photograph showing- postoperative X-ray of the patient

Photograph showing- alingment of fracture site in POP cast after removal of fixator in 11 weeks



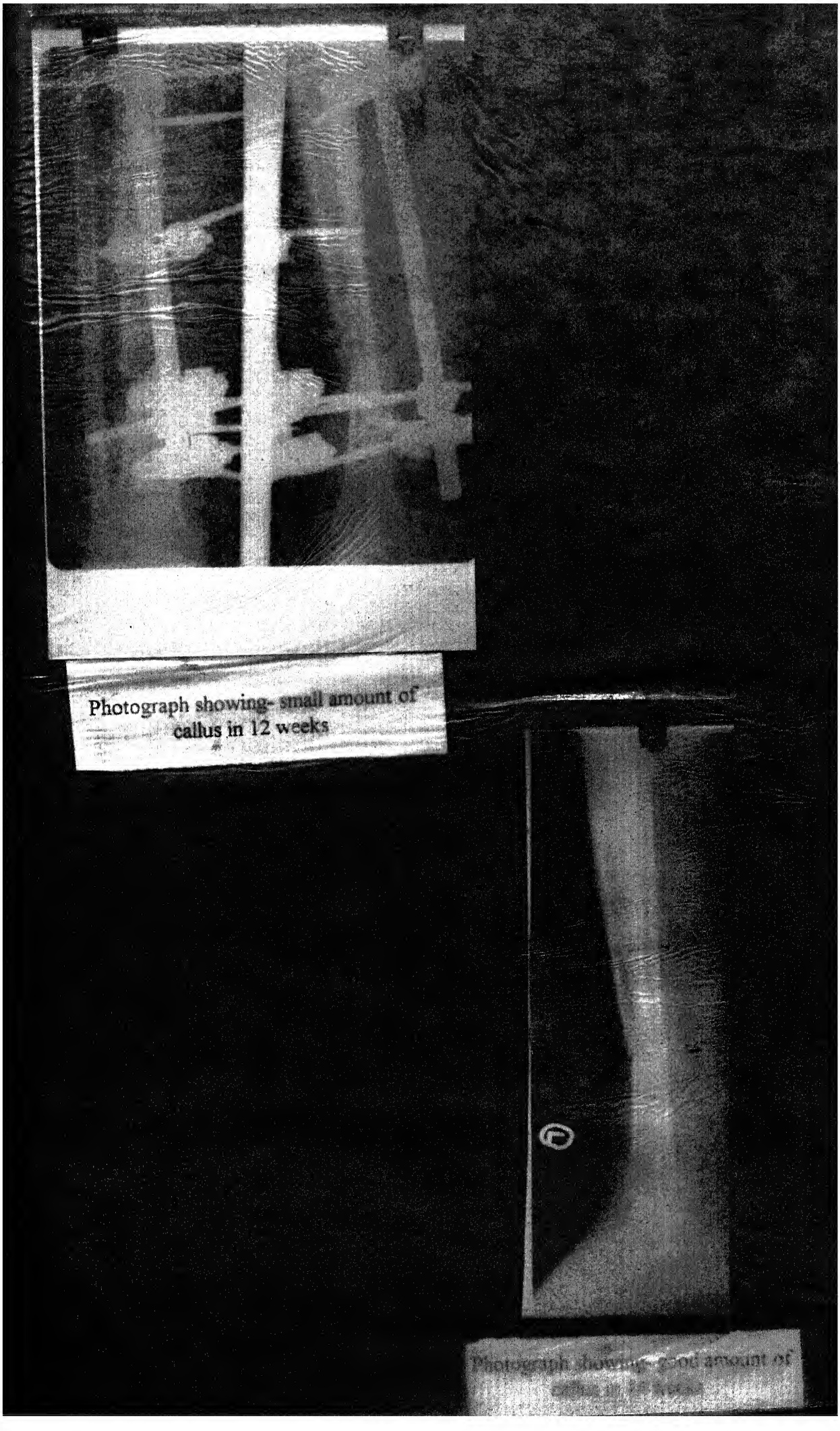
Photograph showing- fair amount of callus at fracture site after 19 weeks

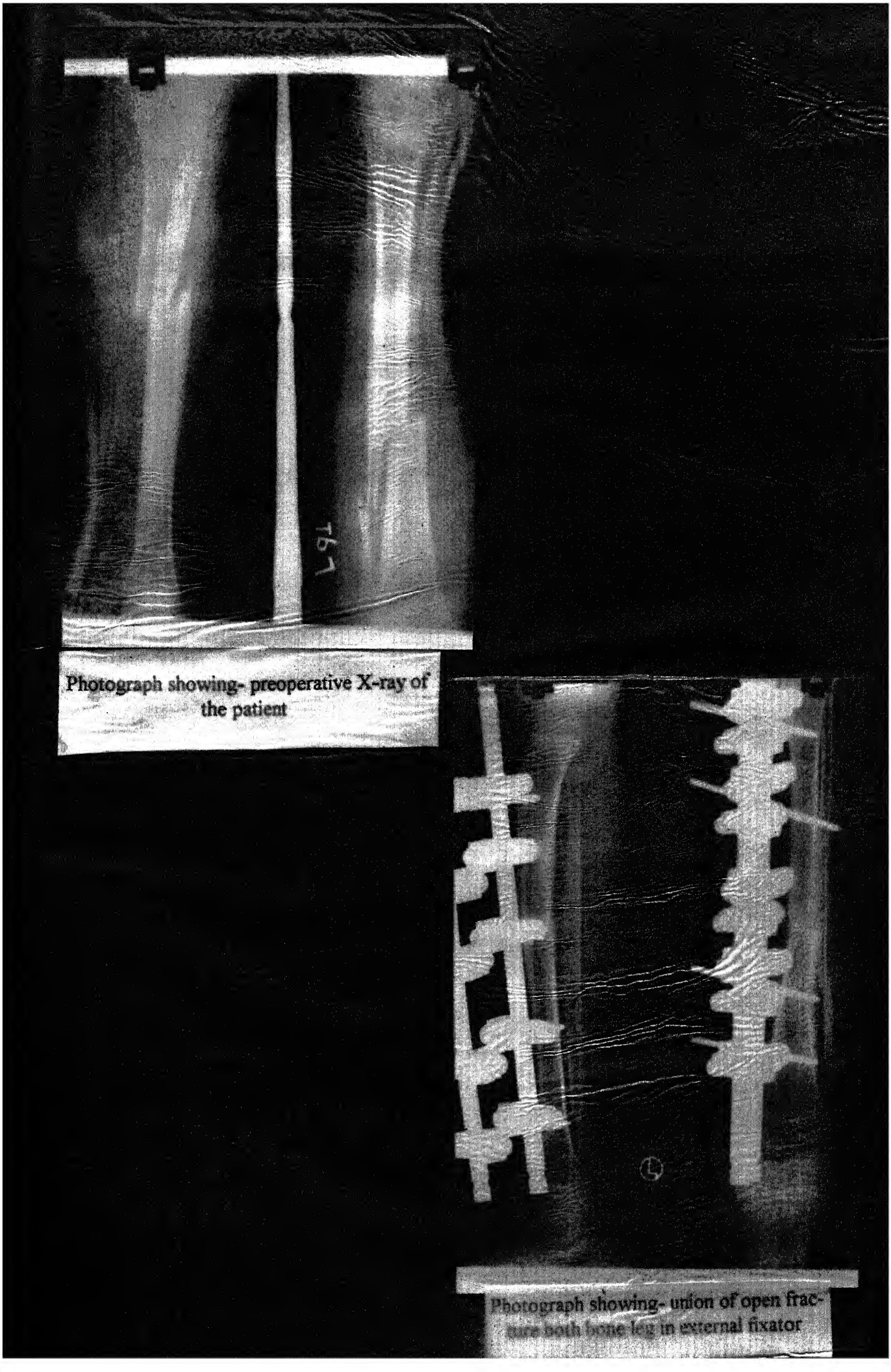

Photograph showing- good amount of
after 27 weeks



Photograph showing- preoperative X-ray of the patient

Photograph showing- postoperative X-ray of the patient

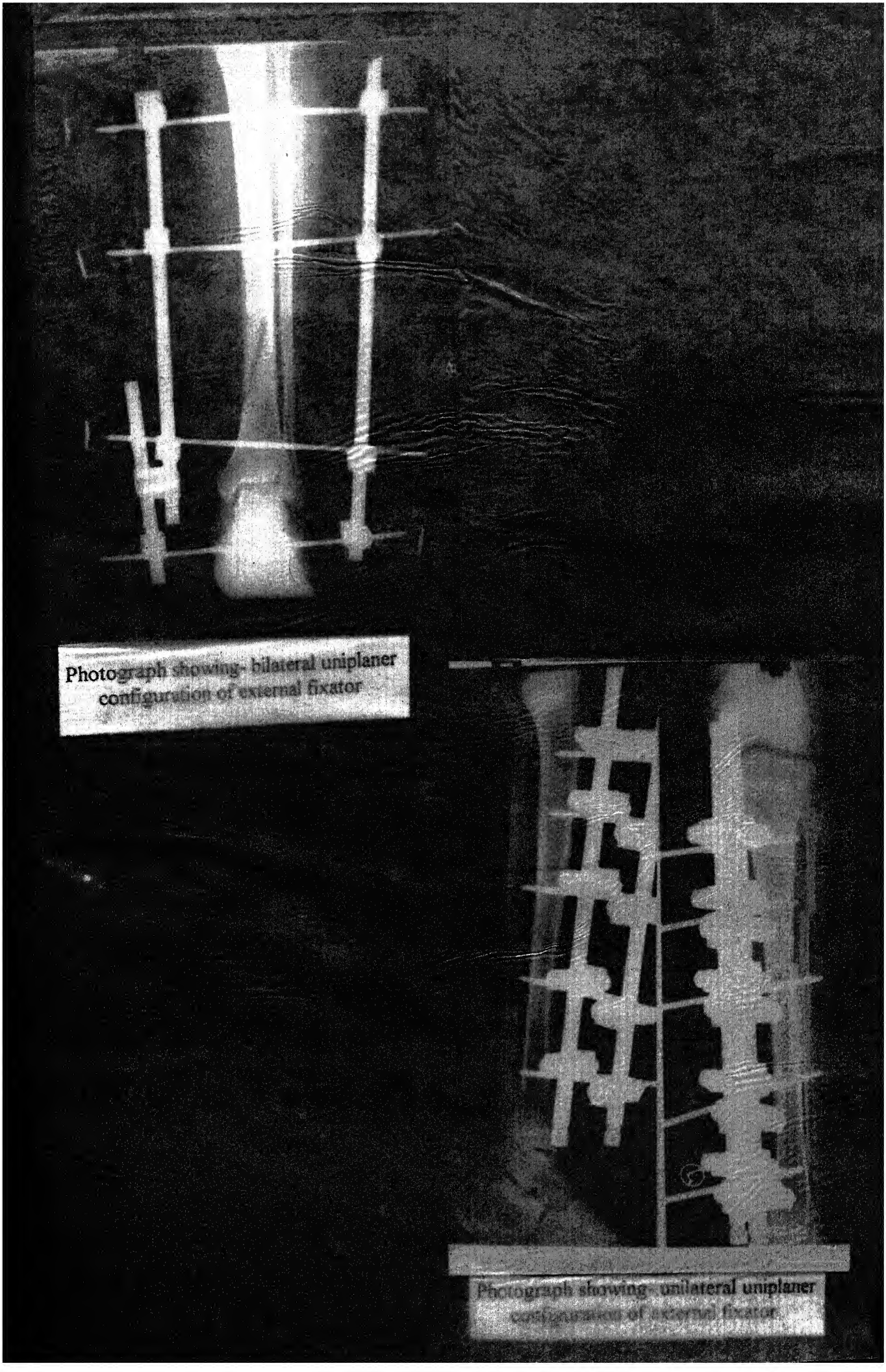

Photograph showing- small amount of callus in 12 weeks



Photograph showing- preoperative X-ray of the patient

Photograph showing- union of open fracture both bone leg in external fixator

Photograph showing unilateral biplanar configuration of external fixator



Photograph showing- bilateral uniplaner configuration of external fixator

Photograph showing- unilateral uniplaner configuration of external fixator

DISCUSSION

DISCUSSION

Over the last years, external fixation has come up as a potential method for treating fracture of leg, specially that of compound comminuted type. The present study was conducted on 18 cases of open fractures of both bone leg admitted in M.L.B. Medical College, Jhansi, The study was conducted to evaluate the role of external fixation in management of open fracture of tibial shaft.

It has been observed that maximum number of patients six (33.34%) were in their IIIrd decade of life giving an impression that younger age group is more commonly involved. Seventeen patients were male and one was female perhaps due to limited outdoor activity of females. Near about 40% of the patients were agriculture workers. In a country like India where 80% of population depend upon farming as an occupation, the results are not surprising.

Road side accident was the commonest mode of injury involving 16 (88.89%) patients. Harvey (1975) has reported that 75% of patients had sustained injury in road side accident, Konstatin (1959) also reported highest incidence of vehicular injuries. AJ Edge, RA Denham (1979) reported 38 cases of complicated tibial fractures, out of 38 cases in this series 28 (73.68%) cases were due to road side accident. Rosenthal and associates reported 104 civilian open fractures in tibia, 71% of which were caused by motor vehicle accident. However in present series 88.89%

of cases were due to road side accident, which is quite comparable to the series of Konstatin (1959), Harvey (1975) and AJ Edge, RA Denhan (1979) and Rosenthal series.

Leg bones are more frequently exposed to injuries because of their location. One third of surface of tibia is subcutaneous throughout its length, so open fractures are more common in the tibia than in any other long bones as a result of high energy trauma, particularly the road traffic accidents. De Bastiani and associate (1984) in their series of 288 fractures, 49 patients had compound injuries and in 55.55 out of 49 patients leg bones were involved.

Patients with open fracture admitted in this Hospital were graded according to modified Gustilo and Anderson's classification of open fractures in to type III - 50%, Type II - 38.89% and type I - 11.11%. Gustilo , Mendoza amd William's (1984) in their series reported that wound sepsis was a problem primarily in type III open fractures and related to the soft tissues damages and periosteal stripping. In their series, the infection rate was type dependant, in type IIIA - 48%, type IIIB - 52%, IIIC - 42% and amputation rate was respectively 9%, 16% and 42%. However in the present series amputation rate was zero.

Tscherne group (1984) in their series reported 3.5% infection rate, who reached hospital with in 20 minutes as compared to 22.2% infection rate in patient who reached to hospital around 10 hour after injury. In the present series most of the cases could

not get proper peripheral care, and attended the hospital more than 10 hours after injury. So that the infection rate in the present study was about 60% much higher than Tscherne (1984). Immediately after admission wound was thoroughly cleaned and covered with sterile dressing and then these open fractures were taken for debridement and stabilization with external fixator.

Compound injuries are high velocity injuries. They may be associated with injury to the nerves and vessels and. In the present study nerve injuries wre found in two cases. Seeddon H.J. (1949) stated that injuries of civil life are less frequently associated with peripheral nerves injuries more than of war injuries. The incidence of associated injuries was 33.54% in present series. The similar incidence (32%) was reported by Konstatin (1958) in his series.

In the present study commenest configuration of external fixator was unlateral biplanner. Following Hoffman (1938), Burny (1972) and Edge and denham (1981), have uniplanar unilateral or half frame, as this low rigidity seems to induce a large amount of Callus. Vidal et al (1979) have suggested that these frames are too week to stabilize the severe tibial fractures. They and others (Karlstrom and Olerud 1975, Edwards 1979) promoted the use of frame of more than one plane.

In the present series maximum duration of application of AO tubular external fixator was 18 weeks and minimum duration was eight weeks, average duration of immobilization in

external fixator was 12 weeks. Fred Behrens & Searles used external fixator for average 14 weeks, quite similar to our series. After removal of fixator, POP cast was applied for further immobilization for average 14 weeks in grade I, 15 weeks in grade II and 20.77 week in grade III compound fractures of tibial shaft.

Gershuni and Halma treated 29 open fractures of tibia and showed that union occured faster when the fixator removed in less than 3.5 month and a cast was applied.

Sick (1983) observed that fracture healing with external fixator was similar to that with rigid internal fixation. In another series Wada and Campbell, Claffey, Gallinaro and associates showed that external fixation in open fractures had lower infection rate was 33% and union rate was 82%. Berhans (1986) stated that unilateral frames are more desirable because they provide better wound access, cause less joint stiffness and diminished the chance of neuro vascular damage while bilateral frames rarely alowed loss of reducion but malunion, pin tract infecion and joint stiffness was more than unilateral frame, they also interfere with opposite leg, making partial weight bearing difficult and full weight bearing almost imposible (Kimmel 1982, Edwards et al 1979).

Union ocured in 14 cases while in two cases delayed union occured and two fractures did not unite. For these cases bone grafting was done. Malunion (deformity) observed in four cases

(one patients had marked deformity where routine activities were disturbed and three had mild deformity where routine activities were not disturbed). Satisfactory range of movement of knee joint was observed in 83.34% of the patients and satisfactory range of movement at ankle joint observed in 72.23%. Union occured in grade I open fracture of tibia in 23.5 weeks while in grade II and III union occured in 26.5 weeks and 33.7% respectively.

Heim, Mark-A and Hess P et al (1991) in thier study stated that the intial treatment of choice for open fracture of both bone leg was the stabilization with external fixator. Their experience with 62 tibial fractures from 1985 to 89 showed that 72% of fractures united with the use of external fixator. delayed union and non union occured in 17% of cases. In our series 77.78% of fractures healed and delayed union was seen in 11.11%, non union was seen in 11.11%. Bone grafting was done for these cases. These observation are quite similar to Heim, Mark and Hass P series.

Lawyer and Lubbers (1980) reported healing of 13 grade I open tibial fractures in an average of 4.7 months (18 weeks) with Hoffman external fixator, 8% required secondary bone grafting. Of the ten type III open fractures, 3 underwent early amputation with the remaining fractures healing in an average of 8.8 months (38 weeks).

Court Brown and associates in a review of 51 type III

open fractures treated with the external fixator, found that type IIIA fractures required an average of 26 weeks to heal and type IIIB required an average of 47 weeks to union.

Gershuni and Halma treated 29 patients of open fractures with A/O external fixator and showed that pin tract infections occured in 23% of cases.

In our series pin tract infection was the most common complication of external fixator observed in five (27.78%) cases. Fourty percent pin tract infection were reported by Tripathi et al (1995) in their study of open fractures of tibial shaft treated by debridement and AO tubular external fixator. Data of these series are quite comparable to our series. Other complication of our series were also quite comparable to these seires. Pin tract problems in Behrens and Searles and that of Bastiani et al have been virtually eliminated by

1. Reduction of soft tissue irritiated around the pins and placement of pin where tibia is subcutaneous.
2. Predrilling of each pin tract with sharp drill bit.
3. Effective pin and frame care.

So that apart from neurovascular injuries and joint stiffness pin tract infection have been the most serious limiting factor in the use of external fixator.

In present series there was no limb shortening in 16 (88.89%) cases. Limb shortening (<1cm) was present in 2 cases.

In the present study, the subjective, objective and radiolodical evaluations were done and it has been observed that good results were obtained in 75.32%, fair in 18.51% and poor in 6.17%.

In present series satisfactory union occured in 16 (89.89%) and two (11.11%) failed to unite.

Edwards CC and Simmons SC et al (1980) presented 202 open fracture of Tibia treated with external fixator found 93% union rate, quite similar rate to union observed in our series.

Behren's and Searles used AO external fixator for 75 compound tibial fractures and stated that out of which 80% fractures united with unilateral and uniplanar fixator. In present series union rate was slightly higher than this series because of small number of patients in our series.

Wade and Campbell, Claffey, Gallinaro and associates showed that external fixation in open fractures had higher rate of union as compared with internal fixation. Union rate of our series was quite comparable to this series.

Kimmel treated 27 severe tibial fractures with external fixator and obtained an 87% union rate and 39% malunion rate. The results of this series are quite similar to present series.

Based on these observations in cases of open fractures of both bone leg, the external fixator to offer a method of treatment, which is simple, safe, provide better reduction, rigid fixation, permits early ambulation and is with relatively less complications as compare to other methods.

CONCLUSION

CONCLUSION

In the present series of 18 cases of open fracture of tibial shaft were treated by debridement and external fixation in the department of Orthopaedics, M.L.B. Medical College, Jhansi and results were evaluated.

Following conclusion were drawn :

1. It was observed that males were predominantly affected and thirds of these were in their IIIrd decade. Almost half of the patients were farmers but had succumbed to injury in road side accident which was the cause in almost 90% of the patients.

2. The predominance of vehicular accident as the cause of the injury is paradoxically higher than in countries with greater amount of road traffic, which report it as the cause in 70-75% of cases.

3. The external fixator is presently accepted as a useful device for treatment of open fracture of tibial shaft.

4. This method provides rigid fixation in the case in which other forms of immobilization are inappropriate. This is most common in severe, open type II & III fractures in which cast or other methods would not permit access for management of the soft tissue wounds.

5. Compression, neutralization or fixed distraction of the fracture fragments is possible with the use of external fixation dictated

by fracture configuration.

6. This method allows direct surveillance of the limb and wound status including wound healing, neurovascular status, viability of skin flaps and tense muscle compartments.

7. Associated treatment for example, dressing changes, skin grafting, bone grafting and wound irrigation is possible without disturbing the fracture alignment or fixation.

8. Simultaneous motion at the proximal and distal joints are possible which aids in reduction of edema, improves nutrition of articular surface and retards capsular fibrosis, joint stiffning, muscle atrophy and osteoporosis.

9. Early patient mobilization may be allowed. With rigid fixation the limb can be moved and positioned without fear for loss of fracture approximation.

10. Pin insertion can be performed under local anaesthesia, if neccessary.

11. Common complications of external fixator pintract infection and joint stiffness.

On the basis of this study it can be concluded that external fixation provide rigid fixator in severe open type II and III fracture of tibia in which cast or other methods would not permit access for management of the soft tissue and dessection for internal fixation appliances would further divitalize and contaminate larger areas and significally increase the risks of

infection. This method allows direct surveillance of wound and frequent dressings are possible with out disturbing the reduction. Associated treatment like skin grafting and bone grafting are possible along with fixator with out disturbing the alingment of fracture site. Movement of adjacent joint and weight bearing allowed without fear for loss of fracture approximation.

Hence its use in clinical practice for complicated open fractures of tibial shaft is strongly recommended.

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